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US 4522070 A

(58) Field of search

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TNEA TNFC

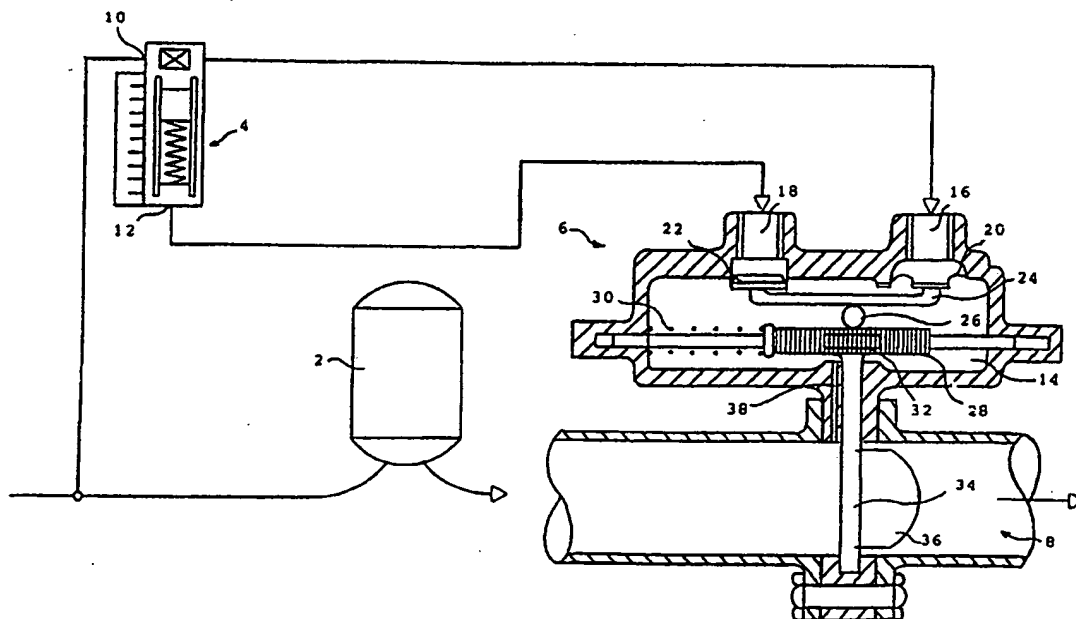
INT CL<sup>6</sup> B01D 35/143, G01D 21/02, G01L 19/00

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(54) Monitoring flow resistance

(57) Flow resistance through a filter 2 is monitored by a differential pressure gauge 4, but the pressure actually applied, to the downstream or upstream side of the gauge, is automatically adjusted as the flow rate through the filter falls, so that the gauge always registers a value corresponding to the full rated flow rate of the filter. In Fig. 1 the pressure downstream of the filter is applied to side 12 of the gauge through duct 38 and disc 22, which is also urged upwards into space 18, to increase the pressure, by a lever 24 whose other end is pushed down by a diaphragm 20 loaded with full upstream pressure. The fulcrum point 26 of the lever is adjusted by deflection of vane 36 in proportion to the flow rate. In Fig. 2 the pressure upstream of the gauge is adjusted by a bleed valve controlled by a venturi flowmeter.

FIGURE 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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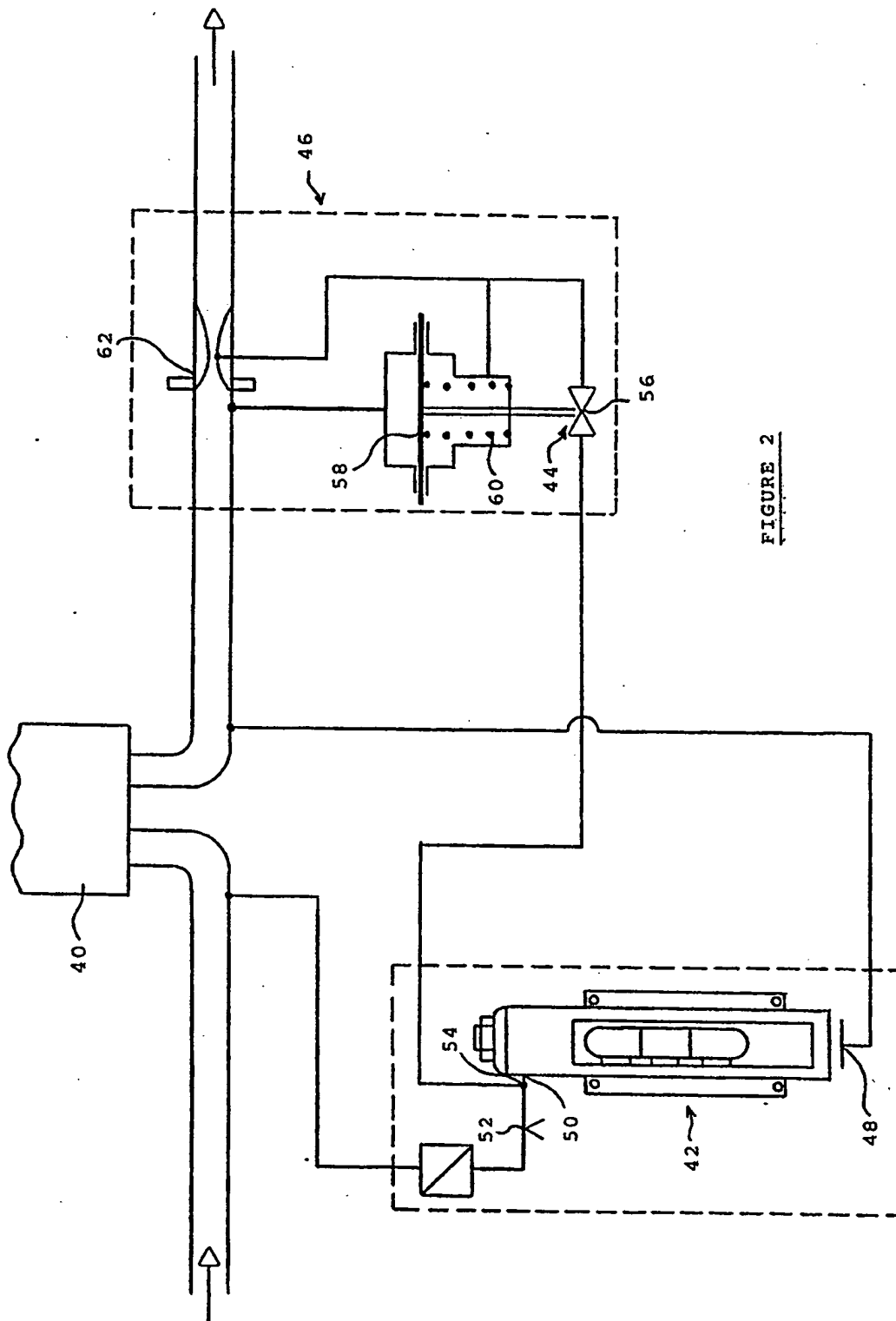


FIGURE 2

This invention relates to fluid circuits and particularly to the efficiency of a flow device in such a circuit. The invention has especial application in relation to filter elements in circumstances where an uncontaminated liquid has to be fed to apparatus of various kinds in order to perform effectively, and the efficiency of the filter element must be carefully monitored.

It is common practice to monitor the efficiency of a flow device by measuring the differential pressure across the device. In particular, the condition of a filter element is often assessed in this way. If the element is partially blocked, the differential pressure will increase. A maximum permitted differential pressure for a given flow rate at or above which elements should be changed is normally provided by the manufacturer. This is defined as the maximum permitted differential pressure at the normal rated flow of the filter. However, at flow rates higher or lower than the rated flow, for the same contamination of the element, the differential pressure gauge will show a higher or lower reading respectively, which is potentially misleading. For example it can result in unnecessary changing of the filter element or in the filter element not being replaced when it should.

The present invention is directed at a system in which the apparent differential pressure across a flow device at a flow rate in a given range is the differential pressure as if it were measured at rated flow. This can ensure that the filter elements are changed only when necessary. To this end, the invention provides a system for determining the resistance through a flow device in a fluid circuit comprising a differential pressure gauge connected across the device, flow measurement means, and means for adjusting the differential pressure as a function of the flow rate; such that the apparent differential pressure is the differential pressure as measured at a rated flow. The range of flow rates in which systems of the invention

will normally be effective is typically 50-100% of maximum flow.

The system operates by altering the pressure at the differential pressure gauge. In particular the adjusting means alters the pressure at one of the upstream and downstream sides. In one preferred embodiment of the invention, the adjusting means comprises a chamber with ports in fluid communication respectively with the upstream and the downstream sides of the differential pressure gauge, one port being closed by a diaphragm in contact with one end of a lever pivotally mounted on a fulcrum, of which the other end supports a disc against the other port, the fulcrum being movable in response to the measured flow to determine a level of leakage past the disc and thereby alter the pressure at said other port. In another embodiment the adjusting means comprises a fixed orifice upstream of the high pressure side of the differential pressure gauge, and a bleed valve in the upstream side of the differential pressure gauge but downstream of the fixed orifice, and coupled to a variable orifice which is controlled by the flow measurement means. In this case, it is the pressure at the upstream side of the differential pressure gauge that is adjusted.

Two embodiments of the invention will now be described by way of example and with reference to the accompanying schematic drawings in which:

Figure 1 shows part of a fluid circuit with a first embodiment of a system according to the invention fitted thereto;

Figure 2 shows part of a fluid circuit with a second embodiment of a system according to the invention fitted thereto.

The system of Figure 1 operates to alter the downstream pressure of a differential pressure gauge as a function of the flow rate. The system comprises a filter device 2 with differential pressure gauge 4 connected across it, and adjusting means 6 coupled to flow

measurement means 8 downstream of the filter device 2. The high pressure side 10 of the gauge 4 is connected to the upstream side of the filter 2, and the low pressure side 12 of the gauge 4 is connected to the downstream side of the filter via adjusting means 6 and flow measurement means 8.

The adjusting means 6 has chamber 14, with ports 16 and 18. The port 16 is in fluid communication with the high pressure side 10 of the differential pressure gauge 4, and is closed by flexible diaphragm 20. The port 18 is in fluid communication with the low pressure side 12 of the differential pressure gauge 4 and is covered by disc 22. The diaphragm 20 and the disc 22 are coupled to opposite ends of a lever 24. Lever 24 is mounted on a movable fulcrum 26 lying on a rack 28. The rack 28 is supported by a spring 30 and is driven by a pinion 32. The pinion 32 is coupled by means of shaft 34 to flow measurement means 8 comprising pivoted vane 36 lying in the downstream flow path of the filter element 2.

Passage 38 and leakage past the shaft 34 allow flow into the chamber 14 such that, with no additional force due to the lever 24, the disc 22 is wholly subject to downstream pressure. This will occur with the fulcrum 26 lying at the right end of the lever 24, directly under the diaphragm 20.

As the fulcrum 26 moves along the lever 24, to the left as shown, in response to increased flow rate, as measured by the vane 36 by means of the rack 28 and pinion 32, there is a downward force on the right end of the lever 24 due to the diaphragm 20 subject to upstream pressure and this force generates an upward force on the disc 22 at the other end of the lever 24. The pressure generated on the low pressure side of the gauge is in excess of the downstream pressure, and the differential pressure is artificially reduced. The fulcrum 26 moves to the right with decreasing flow, artificially increasing the differential pressure.

For example, if in a given system at 100% rated flow

the critical differential pressure is 15 psi., with the flow rate at only 50% of this rated flow, the differential pressure reading will be reduced to around 7 psi. Thus, although the level of contamination of the filter is the same, the filter element would not be changed in the latter case. The apparent differential pressure reading must be altered in the case of reduced flow. This may be accomplished using the system of Figure 1 by fitting the differential pressure gauge with a spring with a rate equal to  $7/15$  of the standard spring that would be used in an uncompensated gauge, ie. 0-14 psi, however the scale is retained as standard, 0-30 psi. The ratio of diaphragm area to disc area, coupled with the fulcrum movement as determined by the movement of the vane is set such that at 100% rated flow the differential pressure across the disc is maintained at  $8/15$  the total differential pressure across the filter.

With the above arrangement and at 50% flow, with the filter in a condition that would generate 15 psi differential pressure at 100% rated flow, and the fulcrum at the right end of the lever providing no compensation, the differential pressure will be 7 psi. However, the scale will read 15 psi. At 100% flow, the fulcrum will have moved to such a position as to reduce the differential pressure of 15 psi by 8 psi; ie, 7 psi will be the measured differential pressure, and the scale will again read 15 psi.

The embodiment of the invention of Figure 2 operates to alter the upstream pressure of a differential pressure gauge as a function of the flow rate. This system has the same basic construction as Figure 1, comprising a filter device 40 with differential pressure gauge 42 connected across it, adjusting means 44 coupled to flow measurement means 46 downstream of the filter device 40.

The low pressure side 48 of the gauge 42 is connected to the downstream side of the filter 40, and the high pressure side 50 is connected to the upstream side via a fixed orifice 52 installed upstream of the

high pressure side 50 of the gauge 42, and a bleed valve 54 downstream of fixed orifice 52 but still upstream of the gauge 42. The bleed valve 54 is connected to variable orifice 56 which can be adjusted according to the downstream flow rate by flow measurement means 48 comprising diaphragm 58 and spring 60 coupled to a venturi 62 in known manner. In this way the upstream pressure side of the differential pressure gauge is adjusted as a function of the flow rate.

Downstream of the variable orifice 56 the bled fluid can be contained within the fluid circuit by connection to the low pressure venturi port as shown. However, as such bled fluid is unfiltered, it may instead be recycled to the system upstream of the filter. In an alternative arrangement, the venturi 62 and if desired, the flow measurement means 46 can itself be located upstream of the filter. In this case, the passage of bled upstream fluid to the venturi throat is not a problem as all the fluid in the venturi has still be be filtered.

In all embodiments of the invention the differential pressure gauge may be fitted with a signal switch so that when the adjusted differential pressure reaches a critical level a signal is given indicating that the filter element should be changed. It may also be desirable to have means to continually provide an indication of the differential pressure.



CLAIMS

1. A system for monitoring the resistance through a flow device in a fluid circuit comprising a differential pressure gauge connected across the device, flow measurement means, and means for adjusting the differential pressure as a function of the flow rate; such that the apparent differential pressure is the differential pressure as measured at rated flow.

2. A system according to Claim 1 wherein the adjusting means alters the pressure on one of the upstream and downstream sides of the differential pressure gauge.

3. A system according to Claim 2 wherein the adjusting means comprises a chamber with ports in fluid communication respectively with the upstream and the downstream pressure sides of the differential pressure gauge, one port being closed by a diaphragm in contact with one end of a lever pivotally mounted on a fulcrum, the other of which supports a disc against the other port, the fulcrum being movable in response to the measured flow to determine a level of leakage past the disc and thereby alter the pressure at said other port.

4. A system according to Claim 3 wherein the chamber is exposed to downstream pressure, the adjusting means modifying the downstream pressure side of the differential pressure gauge.

5. A system according to Claim 3 or Claim 4 wherein the fulcrum is mounted on a rack and pinion and the flow measurement means are coupled to the pinion such that the fulcrum moves in response to the measured flow.

6. A system according to any preceding Claim wherein the flow measurement means comprise a vane mounted in the circuit, and rotatable in response to the fluid flow thereover.

7. A system according to Claim 5 and Claim 6 wherein the vane is mounted on a shaft coupled to the pinion.

8. A system according to Claim 2 wherein the adjusting means comprises a fixed orifice upstream of the high pressure side of the differential pressure gauge, and a bleed valve upstream of the differential pressure gauge but downstream of the fixed orifice, the bleed valve being coupled to a variable orifice which is controlled by the flow measurement means, to adjust the pressure at the upstream side of the differential pressure gauge in response to flow rate.

9. A system according to Claim 8 wherein the flow measurement means comprise a venturi valve in the flow path; the venturi valve being coupled to a diaphragm, movement of which controls the variable orifice.

10. A system according to any preceding Claim further comprising a signal switch connected to the differential pressure gauge such that when the apparent differential pressure reaches a critical level, a signal is given.

11. A system according to any preceding Claim further comprising means continuously providing an indication of the differential pressure.

12. A system according to any preceding Claim wherein the flow device is a filter element.

13. A system for monitoring the resistance through a flow device in a fluid circuit substantially as described herein with reference to Figure 1 or Figure 2 of the accompanying drawings.

14. A fluid circuit including a system according to any preceding Claim.

**Patents Act 1977**

**Examiner's report to the Comptroller under  
Section 17 (The Search Report)**

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**Relevant Technical fields**

- (i) UK CI (Edition K ) B1D (DNEA, DNFC, DNRD)  
BIT (TNEA, TNFC)
- (ii) Int CL (Edition 5 ) G01D 21/02, G01L 19/00,  
B01D 35/143

Search Examiner

R T HAINES

**Databases (see over)**

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

8 MAY 1992

**Documents considered relevant following a search in respect of claims**

1-14

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	US 4522070 A (HAGEN)	1

Category	Identity of document and relevant passages	Relevant to claim(s)

**Categories of documents**

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